



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : A62D 5/00	A1	(11) International Publication Number: WO 00/61239 (43) International Publication Date: 19 October 2000 (19.10.00)
(21) International Application Number: PCT/CA00/00401		(81) Designated States: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
(22) International Filing Date: 11 April 2000 (11.04.00)		
(30) Priority Data: 60/128,927 13 April 1999 (13.04.99) US		
(71) Applicant: DUPONT CANADA INC. [CA/CA]; 7070 Mississauga Road, Mississauga, Ontario L5M 2H3 (CA).		
(72) Inventor: WHYMAN, Andrew, David; 181 Chebucto Drive, Oakville, Ontario L6J 5R1 (CA).		
(74) Agents: CLARIZIO, Dino, P. et al.; Dimock Stratton Clarizio, 20 Queen St. West, Suite 3202, Box 102, Toronto, Ontario M5H 3R3 (CA).		
(54) Title: PERFORATED PROTECTIVE PLASTIC FILMS OR SHEETS		<p>Published</p> <p><i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>
<p>(57) Abstract</p> <p>The invention relates to a protective plastic film or sheet for use in protecting against smoke, heat, corrosive liquids and other hazardous elements. The sheet comprises a fire resistant substrate layer having a primary surface, a layer of titanium covering a major portion of the primary surface of the substrate layer, and a plurality of perforations extending through the polyimide and titanium layers. The perforations allow passage of moisture vapor while the film or sheet provides protection against exposure to smoke, heat, corrosive liquid and other hazardous elements. Also disclosed is equipment for use by emergency personnel made from such plastic films or sheets.</p>		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

TITLE
PERFORATED PROTECTIVE PLASTIC FILMS OR SHEETS

This application claims priority from United States provisional application serial no.

5 60/128,927 filed April 13, 1999.

Field of the Invention:

This invention relates to perforated protective plastic films or sheets, and in particular, to protective films or sheets for protecting individuals from smoke, heat, open flame, corrosive chemicals, etc. in the cases of emergency.

10 **Background of the Invention:**

It is known to provide suits or hoods made of protective material for use by firefighters and other emergency crews to protect them against the effect of smoke, heat, corrosive chemicals, etc. Such protective equipment is typically made of heat resistant fibers. Sometimes, the fibers are coated with a metal layer, metallized ink or metal filled 15 polymer to reflect thermal radiation and reduce heat absorption. Such coatings may include gold, silver or aluminum. However, it has been found that these metal coatings tend to be dislodged from the underlying fabric. Also, corrosive gases or liquids may attack these metal coatings, thus losing their protective properties. As well, some fabrics cannot be provided with a uniform coating of metal. Moreover, metal coatings tend to be 20 very heavy, and they are impervious to water vapour and do not "breathe".

Canadian Patent No. 1333950 discloses a fire and smoke protective hood and also garments and shields that comprise a high temperature resistant plastic material having a layer of titanium. The plastic material is preferably a polyimide, for example Kapton (a trade-mark). The layer of titanium is preferably sufficiently thick to provide the required 25 heat reflection and transmission properties. The titanium may be a layer of several hundred angstroms thick, for example, from 100 to 1000 angstroms thick.

One major problem with the protective garments of Canadian Patent No. 1333950, and also others in the prior art, is that the garments do not "breathe". That is, the garment does not allow water vapor from perspiration to escape. Thus, if the material disclosed in 30 Canadian Patent No. 1333950 were used in making firefighting equipment (such as

bunker gear and proximity suits); there would be physiological problems associated with such equipment. These problems include heat stress, muscle fatigue and dehydration due to the non-breathability of the equipment. Fully encapsulated bunker gear offers protection, but at a price to the firefighter. Studies have shown that firefighter injury rates 5 increase with fatigue, a phenomenon that usually occurs in the post-extinguishment phase (known as the overhaul stage in fire department operations).

Moreover, bunker gear made with the material of the prior art is both heavy and bulky. A firefighter requires a lot of mobility and flexibility while performing operations at fires, accidents and other emergency operations. It is desirable, therefore, to provide equipment 10 that is relatively lightweight, but that also provides the necessary protection and breathability.

These problems are addressed and reduced by the present invention. Accordingly, it is an object of one aspect of the present invention to provide a perforated protective plastic film or sheet that "breathes".

15 It is another object of another aspect of the present invention to provide equipment for firefighters and other emergency personnel that protects the user from smoke, heat, corrosive chemicals, etc. while allowing for "breathability".

Summary of the Invention:

Accordingly, in one aspect of the present invention, there is provided a protective plastic 20 film or sheet for use in protecting against smoke, heat, corrosive liquids and other hazardous elements, comprising:

- a fire resistant substrate layer having a primary surface;
- a layer of titanium that reflects thermal radiation and resists corrosive chemicals, the layer covering a major portion of the primary surface of the substrate layer;
- 25 and
- a plurality of perforations extending through the polyimide and titanium layers, whereby the perforations allow passage of moisture vapor while the film or sheet

provides protection against exposure to smoke, heat, corrosive liquid and other hazardous elements.

In a second aspect of the present invention, there is provided emergency equipment for use by firefighters or other emergency personnel to protect against smoke, heat, corrosive liquids and other hazardous elements, the emergency equipment comprising a protective film or sheet comprising:

- 5 a fire resistant substrate layer having a primary surface;
- 10 a layer of titanium that reflects thermal radiation and resists corrosive chemicals, the layer covering a major portion of the primary surface of the substrate layer; and
- 15 a plurality of perforations extending through the polyimide and titanium layers, whereby the perforations allow passage of moisture vapor while the emergency equipment provides protection against exposure to smoke, heat, corrosive liquid and other hazardous elements.

15 Brief Description of the Drawings:

The preferred embodiments of the present invention will be described with reference to the accompanying drawings in which like numerals refer to the same parts in the several views and in which:

Fig. 1 is a partial cross-sectional view of one embodiment of a film or sheet of the present invention;

Fig. 2 is a partial view of a film or sheet of Fig. 1 coated on one side with a layer of permeable fabric;

Fig. 3 is a partial view of a film or sheet of Fig. 1 coated on another side with a layer of permeable fabric; and

25 Fig. 4 is a partial view of a film or sheet of Fig. 1 coated on both sides with a layer of permeable fabric.

Detailed Description of the Preferred Embodiments:

The present invention will be described with reference to its preferred embodiments.

In the preferred embodiments of the present invention, perforated plastic films or sheets are provided for making fire protective equipment or other emergency equipment that allow for "breathability". As illustrated in Fig. 1, the perforated films or sheets 10 comprise a heat resistant plastic substrate layer 12 perforated with holes 14 of sufficient size to allow water vapor to pass through the perforations 14, but of small enough size to prevent liquids such as water or corrosive chemicals to pass through the perforations 14. The films or sheets 10 retain the protective properties of the prior art films by being substantially impermeable to liquids; however, they allow water vapor to escape there through. Further, the films or sheets 10 may preferably be coated with a layer of titanium 16 to make the films or sheets 10 more resistant to heat, smoke, corrosive chemicals, etc.

The perforations 14 make the films or sheets 10 more breathable therefore allowing the users, such as firefighters and other emergency personnel, to carry out their duties without risk of encountering the problems faced with the protective material of the prior art.

The perforations 14 may be made by any known means such as, but not limited to, mechanical perforating devices, electrostatic discharge, laser impingement, etc. These perforations 14 can range in diameter from fractions of a micron to tens of microns. Smaller perforations provide maximum protection to the user from harmful gases and liquids while still allowing the escape or release of water vapor through the perforations 14. Preferably, the perforations 14 should extend completely through the various layers of the films or sheets 10.

One method for cutting such small perforations is described in U.S. Patent Nos. 4,488,030 and 4,777,338, which are both incorporated herein by reference. An apparatus is described in those two patents that involves the discharge of electrical energy stored in capacitors through electrodes on opposite sides of the polymer fiber.

Another method of cutting perforations is described in United States Patent No. 5550346, which is incorporated herein by reference. An apparatus is described that uses a laser beam to cut perforations in sheet material. The apparatus allows for a predetermined

pattern of perforations to be cut in the sheet material. The apparatus and method of United States Patent No. 5550346 may be used advantageously to cut perforations 14 in the films or sheets 10 of the present invention.

The substrate plastic layer 12 of the film or sheet 10 preferably has a thickness between 5 25 and 75 microns. The layer 12 is preferably made from, but not limited to, a thermoset plastics material such as a heat and chemical resistant polyimide film (such as Kapton® polyimide available from E.I. du Pont of Wilmington Delaware). This layer 12 acts as the substrate for the titanium layer 16. Moreover, Kapton® polyimide, and other polyimide films provide additional thermal, burn-through, chemical (gas and liquid), pathogen and 10 electrical resistance to the film or sheet 10. Also, the polyimide layer 12 allows the titanium coating 16 to be applied with maximum reflectivity, unlike the case found with other substrate fabrics that allow only a discontinuous coating of titanium to be placed on them.

The titanium layer 16 can be applied to one or both surfaces 18 and 20 of the plastic layer 12. In Fig. 1, the titanium layer 16 is illustrated as covering a major portion of one surface 18 only, but the present invention is not limited in such a way. The titanium layer 16 may be applied to both surfaces 18 and 20 of the plastic layer 12 by various known processes such as, but not restricted to, "sputtering", "vacuum metallization", and lamination. The titanium layer 16 may be applied in thicknesses ranging from 100 to 20 1000 angstroms, although it will be understood that useful thicknesses may not necessarily be restricted to this range so long as the titanium layer 16 provides the desired protection.

Some of the desired properties of the titanium layer 16 include, but are not restricted to the following:

25 - the titanium layer 16 reflects radiant heat whether the titanium is coated as a layer on the plastic layer 12 or whether it is buried or embedded into the construction of the plastic layer 12;

- the titanium layer 16 is heat resistant at temperatures at or above those encountered in firefighting and other emergency situations; and

- the titanium layer 16 is resistant to many corrosive liquids and gases thereby maintaining its integrity as a reflective layer when exposed to such environments, unlike the case with aluminum and other metals commonly used to metallize plastics.

5 The titanium layer 16 may be coated onto one or both surfaces of the plastic layer 12, or alternatively, it may be embedded within the structure of the plastic layer 12. Further, the titanium layer 16 may only be coated or embedded on a portion of the plastic layer 12, but preferably, the whole surface of the plastic layer 12 is coated with a titanium layer 16.

10 The perforated titanium coated plastic film or sheet 10 may be used with or without an additional layer of fabric 21 applied to either the titanium layer 16 or to surface 20 of the plastic layer 12. The titanium layer 16 and/or the plastic layer 12 may also be coated with or laminated to a permeable fabric layer 21 as shown in Figures 2, 3 and 4. In the embodiment of Fig. 2, the permeable fabric layer 21 is coated over the titanium layer 16, whereas in the embodiment of Fig. 3, the fabric layer 21 is coated on the plastic layer 12.

15 As for the embodiment of Fig. 4, the film or sheet comprises two permeable fabric layers 21 and 21a; one fabric layer 21 on the titanium layer 16 and another fabric layer 21a on the plastic layer 12.

Common fabrics that may be additionally used include, but are not limited to aramids (such as Nomex® available from E.I. du Pont of Wilmington Delaware) that provides
20 additional resistance to conductive and convective heat transfer and also functions to provide additional tear and puncture resistance to the overall film or sheet 10.

The combination of the attributes of the perforated titanium coated film or sheet 10 of the present invention and the optional fibrous backing material allows the use of lighter weight insulation in the final equipment while providing significantly improved levels of
25 protection for the user. The microscopic perforations 14 allow the escape of moisture vapor from inside the equipment while providing protection against exposure to smoke, heat, corrosive chemicals etc. encountered in fires and other emergency situations.

Although the present invention has been shown and described with respect to its preferred embodiments, it will be understood by those skilled in the art that other changes,

modifications, additions and omissions may be made without departing from the substance and the scope of the present invention as defined by the attached claims.

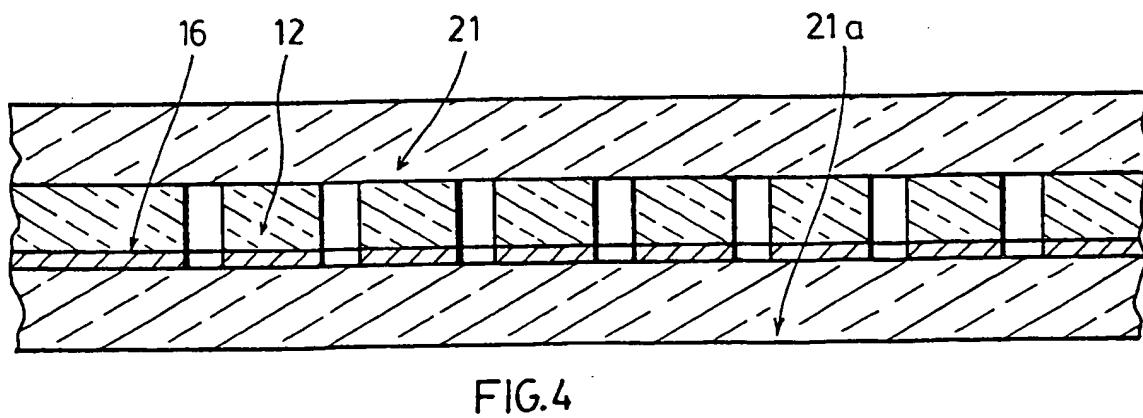
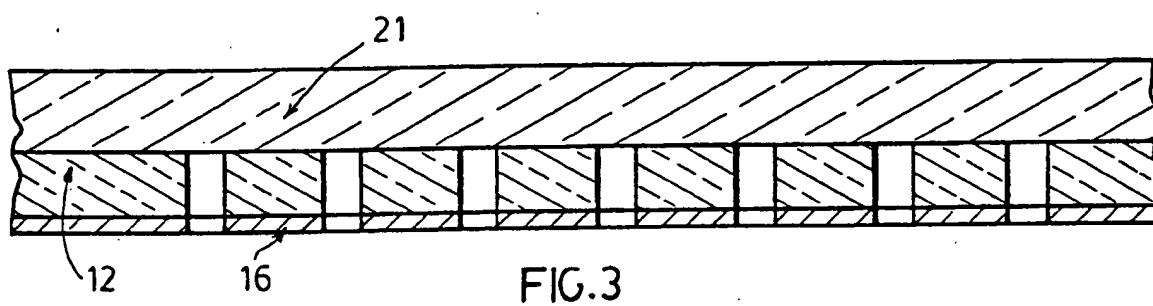
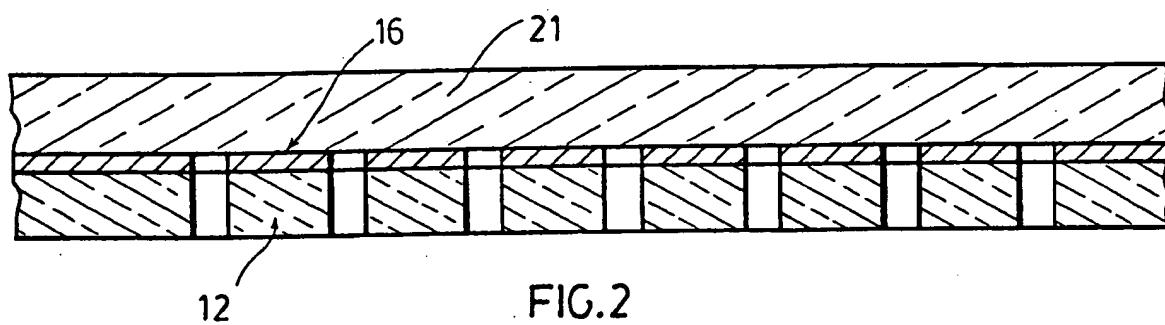
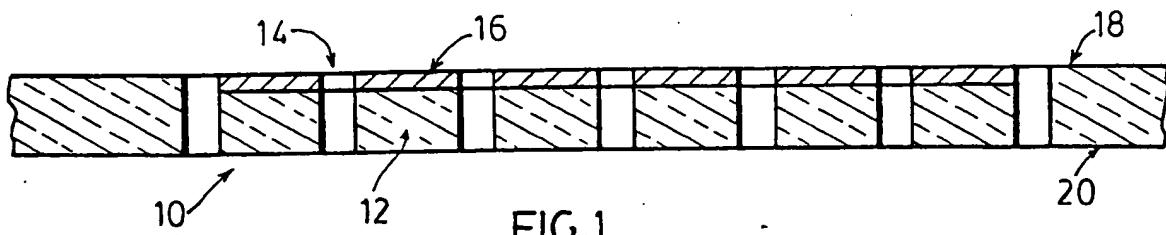
What is Claimed is:

1. A protective plastic film or sheet for use in protecting against smoke, heat, corrosive liquids and other hazardous elements, comprising:
 - a. a fire resistant substrate layer having a primary surface;
 - b. a layer of titanium that reflects thermal radiation and resists corrosive chemicals, the layer covering a major portion of the primary surface of the substrate layer; and
 - c. a plurality of perforations extending through the polyimide and titanium layers,whereby the perforations allow passage of moisture vapor while the film or sheet provides protection against exposure to smoke, heat, corrosive liquid and other hazardous elements.
2. The protective film or sheet of claim 1, whereby the titanium layer covers the entirety of the primary surface.
3. The protective film or sheet of claim 1, comprising a second layer of titanium covering a major portion of a second surface of the substrate layer, and the perforations also extend through the second layer of titanium.
4. The protective film or sheet of claim 1, wherein the titanium layer has a thickness between about 100 to 1000 angstroms.
5. The protective film or sheet of claim 1, whereby the substrate layer comprises a thermoset plastics material.
6. The protective film or sheet of claim 5, whereby the substrate layer comprises a polyimide.
7. The protective film or sheet of claim 1, further comprising an additional layer permeable fibrous backing material.

8. The protective film or sheet of claim 1, whereby the perforations have diameters in the range of about 0.1 to 10 microns.
9. The protective film or sheet of claim 1, whereby the substrate has a thickness in the range of about 25 to 75 microns.
10. Emergency equipment for use by firefighters or other emergency personnel to protect against smoke, heat, corrosive liquids and other hazardous elements, the emergency equipment comprising a protective film or sheet comprising:
 - a. a fire resistant substrate layer having a primary surface;
 - b. a layer of titanium that reflects thermal radiation and resists corrosive chemicals, the layer covering a major portion of the primary surface of the substrate layer; and
 - c. a plurality of perforations extending through the polyimide and titanium layers,whereby the perforations allow passage of moisture vapor while the emergency equipment provides protection against exposure to smoke, heat, corrosive liquid and other hazardous elements.
11. The emergency equipment of claim 10, whereby the titanium layer covers the entirety of the primary surface.
12. The emergency equipment of claim 10, comprising a second layer of titanium covering a major portion of a second surface of the substrate layer, and the perforations also extend through the second layer of titanium.
13. The emergency equipment of claim 10, wherein the titanium layer has a thickness between about 100 to 1000 angstroms.
14. The emergency equipment of claim 10, whereby the substrate layer comprises a thermoset plastics material.

15. The emergency equipment of claim 14, whereby the substrate layer comprises a polyimide.
16. The emergency equipment of claim 10, further comprising an additional layer fibrous backing material and the perforations also extend through the fibrous backing material.
17. The emergency equipment of claim 10, whereby the perforations have diameters in the range of about 0.1 to 10 microns.
18. The emergency equipment of claim 10, whereby the substrate has a thickness in the range of about 25 to 75 microns.

1/1



INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 00/00401

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A62D5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A62D A62B A41D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 348 052 A (BRITISH PETROLEUM CO PLC) 27 December 1989 (1989-12-27) cited in the application page 2, line 12-38; claims ---	1-18
Y	FR 2 612 948 A (CHAVANNE PAUL EDOUARD) 30 September 1988 (1988-09-30) page 4, line 27-30 page 5, line 8,9,27-29; claim 3 ---	1-18
Y	GB 2 277 016 A (MILLS NICHOLAS JOHN) 19 October 1994 (1994-10-19) page 1, line 13-17 page 2, line 23 -page 3, line 2 page 5, line 11-24 page 7, line 1-4 ---	1-18 -/-

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

4 September 2000

Date of mailing of the international search report

13/09/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl.
Fax: (+31-70) 340-3018

Authorized officer

Dalkafouki, A

INTERNATIONAL SEARCH REPORT

Int. tional Application No
PCT/CA 00/00401

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DATABASE WPI Section Ch, Week 199841 Derwent Publications Ltd., London, GB; Class A83, AN 1998-479489 XP002146458 & RU 2 105 517 C (GOLUB V I), 27 February 1998 (1998-02-27) abstract ----	1-18
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 02, 30 January 1998 (1998-01-30) & JP 09 257395 A (NEW GUTSUZU KK), 3 October 1997 (1997-10-03) abstract ----	1
A	DATABASE WPI Section Ch, Week 199841 Derwent Publications Ltd., London, GB; Class A83, AN 1998-479488 XP002146459 & RU 2 105 516 C (GOLUB V I), 27 February 1998 (1998-02-27) abstract ----	1
A	DATABASE WPI Section Ch, Week 198539 Derwent Publications Ltd., London, GB; Class A23, AN 1985-239459 XP002146460 & JP 60 155445 A (JAPAN WOOL TEXTILE CO LTD), 15 August 1985 (1985-08-15) abstract -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/CA 00/00401

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 0348052	A	27-12-1989	AT	151301 T	15-04-1997
			AU	628335 B	17-09-1992
			AU	3454989 A	04-01-1990
			CA	1333950 A	17-01-1995
			DE	68927943 D	15-05-1997
			DE	68927943 T	23-10-1997
			DK	309689 A	23-12-1989
			IE	80446 B	15-07-1998
			JP	2026571 A	29-01-1990
			NZ	229635 A	26-03-1992
			PT	90906 A,B	29-12-1989
			ZA	8903949 A	30-01-1991
FR 2612948	A	30-09-1988	NONE		
GB 2277016	A	19-10-1994	AU	6507494 A	08-11-1994
			WO	9423677 A	27-10-1994
RU 2105517	C	27-02-1998	NONE		
JP 09257395	A	03-10-1997	NONE		
RU 2105516	C	27-02-1998	NONE		
JP 60155445	A	15-08-1985	JP	1657028 C	13-04-1992
			JP	3024896 B	04-04-1991